

Application No. 10/053,699

REMARKS/ARGUMENTS

The above-identified patent application has been reviewed in light of the Examiner's Action dated September 20, 2005. Claims 1, 8, 11, 23, 36, 43 and 44 have been amended without intending to abandon or to dedicate to the public any patentable subject matter. Accordingly, Claims 1-6, 8-11, 13-18, 21-24, 26-31, 33-40 and 42-49 are now pending. As set forth more fully below, reconsideration and withdrawal of the rejections of the claims are respectfully requested.

Initially, applicants would like to thank the Examiner for the courtesies extended during the telephone interview that was held on October 27, 2005. During that interview, the disclosures of the cited references and potential amendments to the claims were discussed. No agreement regarding allowable subject matter was reached during the interview.

The present invention is generally directed to the transmission of communication signals using optical wavelengths through free space. More particularly, embodiments of the present invention are directed to mitigating the adverse effects of turbulence on transmitted signals. This is accomplished by transmitting a beam such that the beam diameter is less than an inner scale of the atmosphere in the vicinity of the transmit aperture. In addition, the divergence angle of the beam is selected so that it exceeds a determined turbulence induced beam deviation at a predetermined distance to a receiver. As can be appreciated by one of skill in the art, and as described in the specification, the divergence angle of a beam of light, outside of the roily range for that beam, is given by the expression w/d , where w is the wavelength of the beam and d is diameter of the beam. By selecting a beam diameter that is less than the inner scale of the atmosphere at the transmit aperture, large area destructive interference is inhibited. In addition, by selecting a divergence angle for the beam (for example by selecting an appropriate beam wavelength and diameter), the far field divergence angle can be made large enough that it can not be steered off the receiver by the turbulence error.

Claims 1-6, 8-11, 13-18, 21-24, 26-31, 33-40, and 42-49 stand rejected under 35 USC §103 as being unpatentable over U.S. Patent No. 5,303,024 to Thierman ("Thierman") in view of U.S. Patent No. 5,150,171 to Hill et al ("Hill"). In order to establish a prima facie case of

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obviousness under §103, there must be some suggestion or motivation to modify the reference or to combine the reference teachings, there must be a reasonable expectation of success, and the prior art reference or references must teach or suggest all of the claim limitations. (MPEP §2143.) Because the cited references, whether considered alone or in combination, do not teach, suggest or describe transmitting a communication signal using a laser beam having a diameter that is less than an inner scale of an atmosphere and a divergence angle selected to exceed a turbulence induced beam deviation at a receiver, the rejections of the claims as obvious should be reconsidered and withdrawn.

The Thierman reference is directed to a scintillometer for measuring the inner scale of atmospheric refractive index fluctuations. (Thierman abstract.) More particularly, Thierman discusses a laser diode for producing a beam that has passed through a birefringent material that splits the radiation into two displaced, orthogonally polarized components that are then passed through the atmosphere. (Theirman abstract; Fig. 1.) The intensity of the radiation originating from each of the two virtual sources is measured at two displaced detectors, in order to calculate the inner scale of refractive index fluctuations. In order to obtain a sufficiently high radiation intensity at the detector, a source with a small aperture, a small divergence and a sufficiently high output power is required. (Theirman col. 3, lines 4-7.) Typical divergences used by Theirman are several milliradians. (Theirman col. 3, lines 45-46.) Accordingly, Theirman is directed to measuring characteristics of the atmosphere, and not to avoiding the effect of atmosphere on the transmission of information. Accordingly, Theirman does not teach, suggest or describe various elements of the pending claims, including determining an inner scale in an atmosphere and then emitting a beam comprising a modulated communication that has a diameter that is less than the determined inner scale and that has a divergence angle that is selected so that it exceeds a determined amount.

The Hill reference is generally directed to a fluxes scintillometer. More particularly, Hill discusses a laser scintillometer that measures the variance of the log intensity of diverged laser light received via a first path and a large aperture scintillometer that measures the variance of the log intensity of light from an incoherently illuminated source received via a second path. (Hill,

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abstract.) The ratio of the two measured variances gives the inner scale of turbulence. (Hill, abstract.) The Hill reference is cited for teaching the use of a broadband (e.g. multiple wavelength) divergent modulated light beam. However, the modulated light beam of Hill is produced by a light emitting diode. In contrast, the beam used to transmit information recited by the pending claims is produced by a laser, and is emitted as collimated light.

With the above general description of the claimed invention and the cited references, it can be appreciated that at least the following italicized features of the independent claims are not taught, suggested or described by the cited references:

1. A method for transmitting optical signals through free space, comprising:
providing a transmit aperture;
determining an inner scale in an atmosphere near the transmit aperture; and
emitting a single broad, divergent and collimated beam generated by a laser and comprising a modulated communication, wherein the beam has a diameter at the transmit aperture that is less than the determined inner scale near the transmit aperture and within the Rayleigh range, and wherein a divergence angle of the beam is selected so that it exceeds a determined turbulence induced laser deviation at a predetermined distance to a receiver.
11. An optical transmission apparatus, comprising:
a radiation source comprising a *laser for emitting a collimated beam* of radiation through free space;
a modulator in communication with the radiation source for *modulating the beam with information*;
a transmit aperture, wherein the transmit aperture has a size sufficient to output a *maximum beam diameter that is less than a determined inner scale of an air current at or near the transmit aperture, and wherein the beam of radiation has a divergence angle that exceeds a determined turbulence induced beam deviation at a receiver.*

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23. An optical transmission apparatus, comprising:
a laser radiation source;
a modulator in communication with the radiation source for modulating a beam output by the radiation source with information;
a transmit aperture, wherein the transmit aperture causes the beam to be divergent, wherein a divergence angle of the single beam is at least about 20 μ rad, and wherein the diameter of the single beam at the transmit aperture is less than an inner scale of an air current at or near the transmit aperture.

36. A method for designing an optical transmitter, comprising:
providing an optical transmitter capable of emitting a laser beam;
determining an inner scale at a proposed location for a transmit aperture;
determining a worst case atmospheric induced deviation for the laser beam;
selecting a transmit aperture size sufficient to output a maximum beam diameter that is less than the inner scale;
selecting an optical wavelength, wherein said selected wavelength and said beam diameter resulted in an angle of divergence for the laser beam that is greater than about 50 mrad; and

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The cited references do not teach, suggest or describe each and every element of the pending claims. Accordingly, for at least the reasons set forth herein, the rejections of the claims as obvious should be reconsidered and withdrawn.

The application now appearing to be in form for allowance, early notification of same is respectfully requested. The Examiner is invited to contact the undersigned by telephone if doing so would expedite the resolution of this case.

Respectfully submitted,

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